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⑭ 同軸型低域通過濾波器

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## 明 細 書

## 1. 発明の名称

同軸型低域通過濾波器

## 2. 特許請求の範囲

- (1) 内周面と外周面とを有する同軸状誘電体を有し、前記誘電体の両端面近傍領域の誘電体の外径が、中央領域の誘電体の外径よりも小さい構造を有し、前記内周面に接して中心導体が挿入固定されており、前記外周面に沿って外導体が設けられた構造の線路を単位同軸線路とし、前記単位同軸線路を複数個縦続接続して構成したことを特徴とする同軸型低域通過濾波器。
- (2) 単位同軸線路間が金属スリーブを介して接続されていることを特徴とする特許請求の範囲第1項記載の同軸型低域通過濾波器。
- (3) 単位同軸線路を構成する中心導体の一端に雄ネジ部、他端に雌ネジ部を設け、前記雄ネジ部及び雌ネジ部により単位同軸線路が接続されていることを特徴とする特許請求の範囲第1項又は第2項記載の同軸型低域通過濾波器。

## 3. 発明の詳細な説明

## 産業上の利用分野

本発明はVHF～UHF帯で用いる、小型で耐振特性の良好な同軸型低域通過濾波器に関するものである。

## 従来例の構成とその問題点

従来この帯域での低域通過濾波器(LPF)は、第1図に示すような高インピーダンス、低インピーダンス線路を同軸で構成することが多く、広帯域、低損失の電気的特性をもつことが知られている。第1図aは長手方向の部分断面図、第1図bは第1図aのA-A'における断面図である。第1図において101、102は入出力コネクタ、

103は同軸外導体、104は中心導体をあらわす。中心導体104は、105で示す小さい径の部分と106で示す大きな径の部分が交互に接続された構造となっている。いま中心導体の半径をa、外部導体内径をbとし、中心導体と外導体の空間の媒質の比誘電率を $\epsilon_r$ とすると、同軸線路のインピーダンスZは

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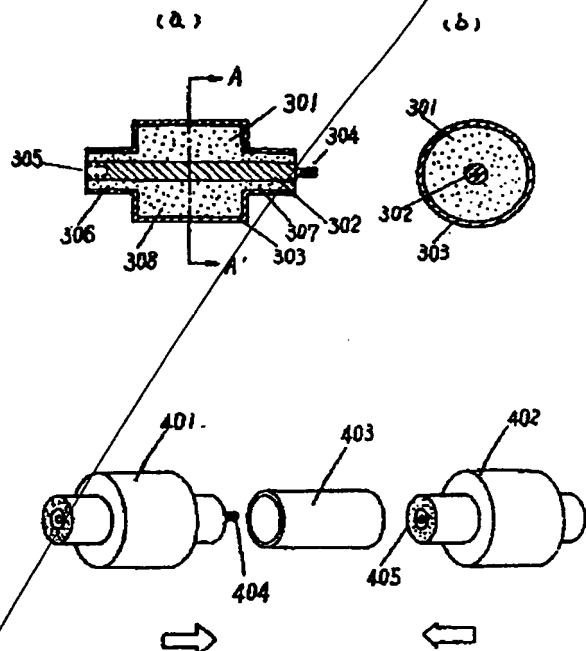
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APPLICANT : MATSUSHITA ELECTRIC IND CO LTD;

INVENTOR : YAMASHITA SADAHIKO;

INT.CL. : H01P 1/202

TITLE : COAXIAL TYPE LOW-PASS FILTER



**ABSTRACT :** **PURPOSE:** To reduce the titled filter at its size and to improve vibration-proof characteristics by using plural unit coaxial lines each of which is composed of a dielectric element provided with a center conductor inserted so as to be brought into contact with the dielectric element and has the constitution that the diameter of an external conductor is reduced at its both ends and expanded at its center.

**CONSTITUTION:** A dielectric cylinder 301 is constituted so that the external diameter is reduced at both side end parts 306, 307 and expanded at the center part 308 and has a circular hole having a coaxially uniform internal diameter. A conductive film is formed on the external periphery of the dielectric cylinder 301 by plating or printing as an external conductor 303 and a metallic cylindrical rod 302 having an external thread 304 and an internal thread 305 on both sides is inserted and fixed into/on the central circular hole to constitute a unit coaxial line. The unit coaxial lines 401, 402 are arranged so that the external and internal threads 404, 405 are opposed and the leading end parts of the unit coaxial lines are inserted into a metallic sleeve 403 and fixed by the individual threads to connect the unit lines like multi-stages. In said constitution, a high impedance line and a low impedance line are obtained at a part having the large external diameter of the unit coaxial line and a part having a small external diameter respectively.

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$$Z = 60 \times \ln(b/a) / \sqrt{\epsilon_r} (\Omega)$$

であらわされる。したがって中心導体106の部分は線路インピーダンスが高く、106の部分はインピーダンスが低い構造となる。また高インピーダンス部分はインダクタ、低インピーダンス部分はキャパシタであらわすことができるから、第1図の等価回路は第2図の如くあらわすことができる。

第2図において201, 202は入出力端子、203~206はインダクタ、207~209はキャパシタで、これは低域通過フィルタ(LPF)の回路そのものである。

このLPFの電気的特性は、同軸線路を用いるため低損失で、かつ高い周波数まで使用でき、かつ広帯域な設計が可能であるためひろく實用されているが形状が大きいこと、中心導体の加工が難しいこと、中心導体を機械的に支持する機構が必要で、支持の方法が悪いと、耐振特性が著しく劣化すること等の欠点を有していた。

#### 発明の目的

を形成し、外部導体303とし、中心部の円孔には、両側に雄ネジ304、雌ネジ306を有する金属円柱棒302が挿入固定されている。

第4図には、第3図お単位同軸線路を多段に接続してLPFを構成する場合の、単位同軸線路を接続固定する方法を示している。単位同軸線路401, 402は、雄ネジ404、雌ネジ406が対向するように配置し、単位同軸線路の先端部を金属スリーブ403に挿入し、互のネジで固定する。金属スリーブ403は、接続部の外導体の接地を完全にとるためと、機械的な強度を増大する目的があり、導電性接着剤等を用いて固定される。

このようにして接続固定されたLPFの外観を第5図に、断面を第6図に示す。601, 602は入出力コネクタ、603~606は単位同軸線路、607~611は金属スリーブを示す。

このような構造のLPFにおいて、高インピーダンス線路は単位同軸線路の外径の大きい部分で、低インピーダンス部分は外径の小さな部分で実現

本発明は従来の同軸型低域通過フィルタの電気的性能と維持しつつ、小型化と耐振特性の向上を改善した同軸型低域通過フィルタ(LPF)を提供せんとするものである。

#### 発明の構成

最近高誘電率低損失の誘電体が開発され、その材料を用いた同軸共振器等が開発されているが、本発明はこの種の誘電体を用いて、この誘電体に接して中心導体が設けられており、外導体が両端で小さく、中央で大きくした構成の同軸線路を基本単位とし、これらを複数個縦続接続した構成の同軸型低域通過フィルタを実現しようとするものである。

#### 実施例の説明

第3図に本発明の同軸型低域通過フィルタとして用いる単位同軸線路を示す。aは長手方向断面図、bはaのA-A'における断面図である。301は誘電体円筒で、両側端部306, 307の外径は小さく、中央部308の外径は大きく、かつ同軸状に一樣な内径を有する円孔を有している。誘電体301の外周は、ノッキまたは焼付等で導體膜

する。すなわち、従来は内導体の径を変えて線路インピーダンスを変えたのに対し、本発明においては、内導体の径は一定にして、外導体の径を変えて高インピーダンス、低インピーダンス部を実現する。

内外導体間には誘電体が充てんされた構造となるから、耐振構造が従来の構造に対して著しく改善されるほか、誘電体による波長短縮効果(波長が $1/\sqrt{\epsilon_r}$ に短縮される)のため形状(長さ方向)の小型化が期待できる。また単位同軸線路間が強固に固定保持されるため、耐振特性に優れている。

さらに本発明の特徴は、単位同軸線路の数を任意に増減できるために、電気的な特性を容易にかえることができる点にある。第7図は接続の個数を増やした時の減衰量の増加を示すグラフである。このような特性の変化はほとんど同一の構成部分を用いて実現可能であるため、コスト低減も可能となる。

#### 発明の効果

以上述べたように、本発明は誘電体を利用して、誘電体に接して中心導体を設け、外導体の径が両端で小さく、中央で大きくした構成の単位同軸線路を複数個用いて実現するＬＰＦで、耐振特性が良好で、小型でかつ、多段構成が容易に用いる特長を有し、その実用上の価値はきわめて大きい。

#### ４．図面の簡単な説明

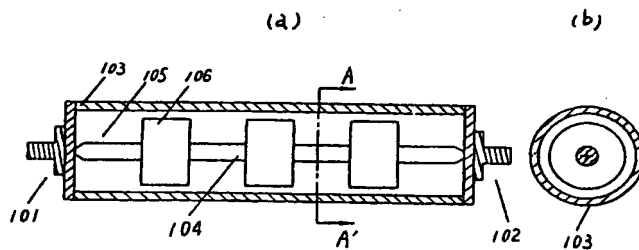
第１図 a は従来の同軸型低域濾波器の長手方向の一部断面図、第１図 b は第１図 a の A-A' における断面図、第２図は第１図の濾波器の等価回路を示す図、第３図 a は本発明で用いる単位同軸線路の長手方向断面図、第３図 b は第３図 a の A-A' における断面図、第４図は本発明の単位同軸線路を接続する方法を示す斜視図、第５図は本発明による同軸型低域濾波器の斜視図、第６図は第５図に示す同軸型低域濾波器の断面図、第７図は単位共振器の接続数を増やした時の応答の変化を示す説明図である。

301 ……誘電体、302 ……中心導体、303 ……外導体（導体膜）、501、502、601、602

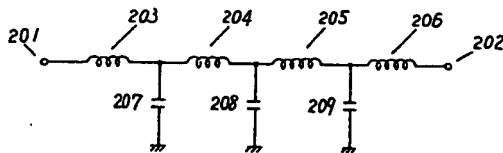
……出力コネクタ、603～606、603～606 ……単位同軸共振器、607～611、607～611 ……金属スリーブ。

代理人の氏名 弁理士 中 尾 敏 男 ほかに1名

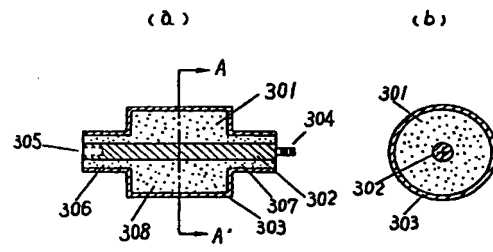
第 1 図



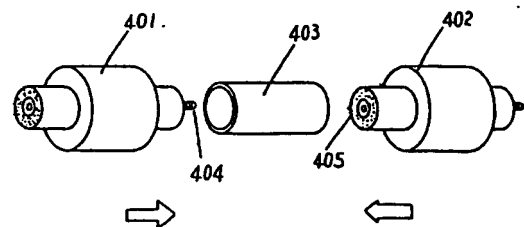
第 2 図



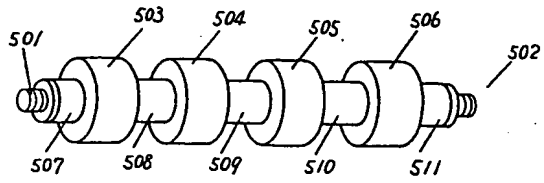
第 3 図



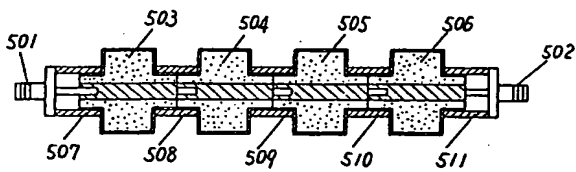
第 4 図



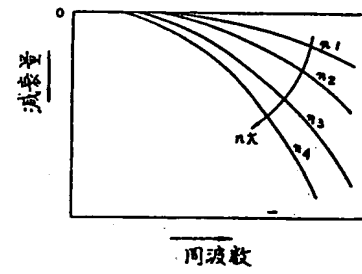
第 5 図



第 6 図



第 7 図



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COAXIAL TYPE LOW-PASS FILTER

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[There are no amendments to this patent.]

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### Claims

1. A coaxial type low-pass filter characterized by the following facts: it has a coaxial dielectric having an inner peripheral surface and an outer peripheral surface; the outer diameter of the dielectric in the portions near the two end surfaces is smaller than that in the central portion; a center conductor in contact with the inner peripheral surface is inserted and fixed; and an outer conductor is formed along said outer peripheral surface; the line with this constitution is taken as a unit coaxial line; and plural said unit coaxial lines are connected in series to form the coaxial type low-pass filter.

2. The coaxial type low-pass filter described in Claim 1 characterized by the fact that the unit coaxial lines are connected to each other via a metal sleeve.

3. The coaxial type low-pass filter described in Claim 1 or 2 characterized by the fact that a male threaded portion is provided at one end of the center conductor that forms the unit coaxial line, and a female threaded portion is provided at the other end; and said male threaded portion and female threaded portion are used to connect the unit coaxial lines to each other.

### Detailed explanation of the invention

#### Industrial application field

The present invention pertains to a coaxial type low-pass filter that is small, and has good vibration resistance, and is for use in the VHF-UHF band.

#### Constitution of the prior art and problems

In the prior art, the low-pass filter (LPF) for said band is usually composed of high-impedance lines and low-impedance lines connected coaxially, as shown in Figure 1. It has broadband, low loss electrical characteristics. Figure 1a is a partially cut cross section in the longitudinal direction. Figure 1b is a cross section taken across A-A' in Figure 1a. In Figure 1, (101), (102) are input/output connectors; (103) represents a coaxial outer conductor; and (104) represents a center conductor. Said center conductor (104) has a structure in which small-diameter portions (105) and large-diameter portions (106) are connected alternately. Now, if the radius of the center conductor is (a), the inner diameter of the outer conductor is (b), and the relative dielectric constant of the medium in the space between the center conductor and outer conductor is  $\epsilon_r$ , the impedance Z of the coaxial line is:

$$Z = 60 \times \ln(b/a) / \sqrt{\epsilon_r} (\Omega)$$

Consequently, the line impedance is higher for the center conductor portion (105), and it is lower for the portion (106). Because the high-impedance portion may be represented as an

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inductor, while the low-impedance portion may be represented as a capacitor, Figure 2 shows the equivalent circuit for Figure 1.

In Figure 2, (201), (202) represent input/output terminals, (203)-(206) represent inductors, and (207)-(209) represent capacitors. They form a low-pass filter (LPF) circuit.

Since the electrical characteristics of the LPF for use as a coaxial line should be appropriate to provide low loss up to a high frequency, broadband design can be performed. However, the shape becomes larger, and a mechanism for providing mechanical support of the center conductor is needed. Because the supporting scheme is poor, the vibration resistance is significantly degraded. This is undesirable.

#### Purpose of the invention

The purpose of the present invention is to provide a coaxial type low-pass filter (LPF) characterized by the fact that while the electrical characteristics of the conventional coaxial type low-pass filter are maintained, it is smaller and more vibration resistant.

#### Constitution of the invention

Recently, dielectrics with a high dielectric constant and low loss have been developed, and the materials have been used in developing a coaxial resonance region, etc. The present invention adopts such dielectric material in providing a coaxial type low-pass filter characterized by the following facts: the basic unit is a coaxial line with a structure in which a center conductor is arranged in contact with said dielectric, and the outer conductor is smaller at the two ends and larger in the central portion; multiple said units are connected in series to form the coaxial type low-pass filter of the present invention.

#### Explanation of the application examples

Figure 3 is a diagram illustrating a unit coaxial line for the coaxial type low-pass filter of the present invention. (a) is a cross section in the longitudinal direction; (b) is a cross section taken across A-A' in (a). (301) represents a dielectric cylinder, which has a smaller outer diameter at its two side end portions (306), (307), a larger outer diameter at its central portion (308), and a coaxial circular hole with a uniform inner diameter. A conductor film is formed on the outer periphery of dielectric (301) by means of plating or baking, to serve as outer conductor (303). Cylindrical metal rod (302) having male threaded portion (304) and female threaded portion (305) at its two ends is inserted and fixed in the central circular hole.

Figure 4 is a diagram illustrating the method for connecting and fixing the unit coaxial lines shown in Figure 3 to form the LPF composed of plural unit coaxial lines in series. Unit coaxial lines (401), (402) are arranged with their male threaded portion (404) and female

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threaded portion (405) facing each other. The tip parts of the unit coaxial lines are inserted into metal sleeve (403), and they are fixed to each other with the threaded portions screwed together. Metal sleeve (403) ensures perfect grounding of the outer conductor of the connecting portion, and increases the mechanical strength. It is fixed in place by means of an electroconductive adhesive or the like.

Figure 5 shows the appearance of an LPF prepared by connection and fixing as described. Figure 6 is a cross section. (501), (502) represent the input/output connectors, (503)-(506) represent the unit coaxial lines, and (507)-(511) represent metal sleeves.

In the LPF with the aforementioned constitution, the high-impedance line is realized with the portion of the unit coaxial line having the larger outer diameter, while the low-impedance line portion is realized with the portion having the smaller outer diameter. That is, unlike the prior art in which the diameter of the inner conductor varies to change the line impedance, in the present invention the diameter of the inner conductor is constant, while the diameter of the outer conductor is changed to realize the high-impedance portions and low-impedance portions.

Because the space between the inner conductor and outer conductor is filled with the dielectric, the vibration resistance is much better than in the conventional structure. Also, due to the effect of the dielectric in reducing the wavelength (the wavelength can be shortened to  $1/\sqrt{\epsilon_r}$ ), the size (in the longitudinal direction) can be reduced. Also, because the unit coaxial lines are fixed and held to each other reliably, the vibration resistance is excellent.

In addition, the present invention has a characteristic feature that the number of unit coaxial lines can be adjusted at will. Consequently, it is possible to change the electrical characteristics easily. Figure 7 is a graph illustrating the increase in the decay amount when the number of units connected is increased. This change in the characteristics can be realized using nearly the same structural part, so that the cost can be reduced.

As explained above, according to the present invention, each unit coaxial line has the following structure: A dielectric is used, a center conductor is placed in contact with the dielectric, and the outer conductor has a smaller diameter at its two ends and a larger diameter at its center. Plural said unit coaxial lines are used to realize the coaxial type low-pass filter of the present invention. Consequently, the obtained LPF has excellent vibration resistance and is small in size, and can easily be given a multi-stage constitution. Due to these characteristic features, it has a very high value in practical applications.

#### Brief description of the figures

Figure 1a is a partially cut longitudinal cross section of the coaxial type low-pass filter in the prior art. Figure 1b is a cross section taken across A-A' of Figure 1a. Figure 2 is a diagram illustrating the equivalent circuit of the filter shown in Figure 1. Figure 3a is a longitudinal cross

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section of the unit coaxial line used in the present invention. Figure 3b is a cross section taken across A-A' of Figure 3a. Figure 4 is an oblique view illustrating the method of connecting the unit coaxial lines of the present invention. Figure 5 is an oblique view illustrating the coaxial type low-pass filter of the present invention. Figure 6 is a cross section of the coaxial type low-pass filter shown in Figure 5. Figure 7 is a diagram illustrating the variation in response when the number of resonance units is increased.

- 301 Dielectric
- 302 Center conductor
- 303 Outer conductor (conductor film)
- 501, 502, 601, 602 Output connector
- 503-506, 603-606 Unit coaxial resonator
- 507-511, 607-611 Metal sleeve

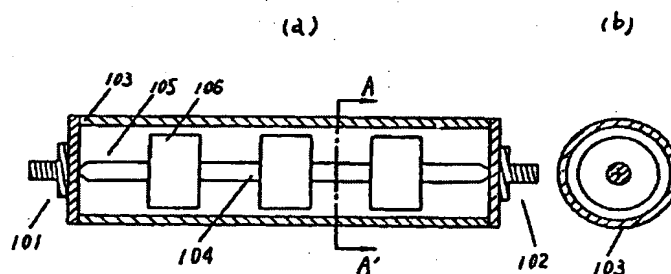


Figure 1

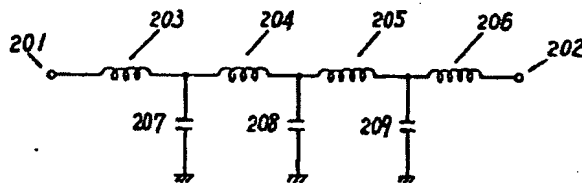


Figure 2

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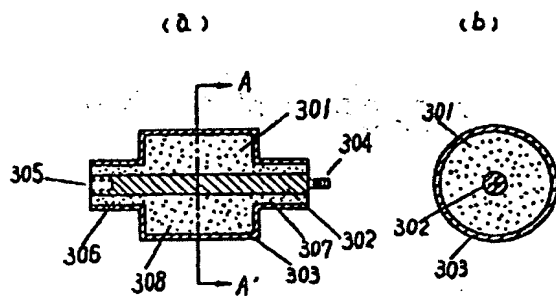


Figure 3

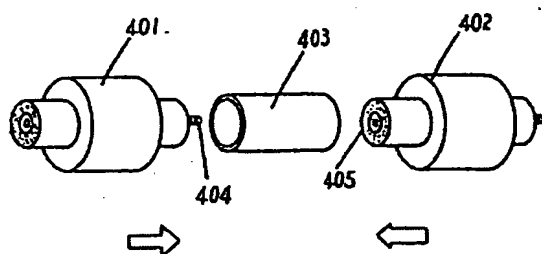


Figure 4

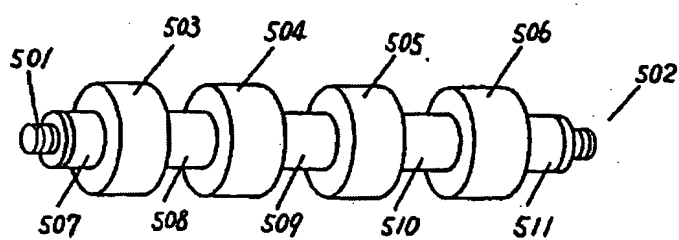


Figure 5

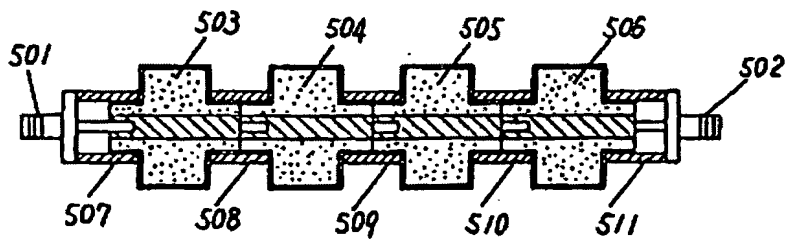


Figure 6

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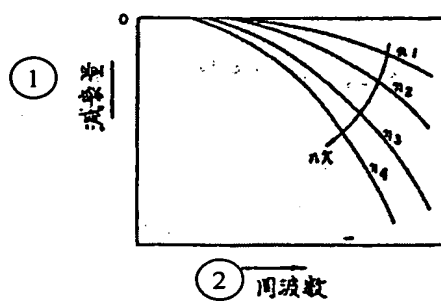


Figure 7

Key: 1 Decay amount  
2 Frequency

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